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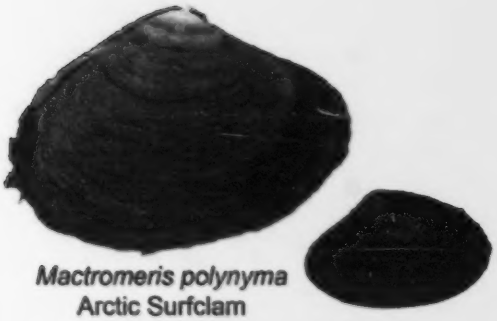
Maritimes Region
Canadian Science Advisory Secretariat
Science Advisory Report 2011/068

ASSESSMENT OF THE ARCTIC SURFCLAM (*MACTROMERIS POLYNYMA*) STOCK ON BANQUEREAU IN 2010



Mactromeris polynyma
Arctic Surfclam

D. Roddick BIO

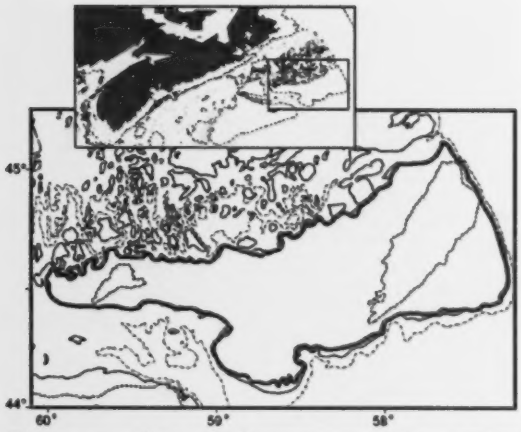


Figure 1: Map of Banquereau. The survey boundary is the red line.

Context:

The hardshell clam fishery on Banquereau started in 1986, with an exploratory fishery. The species targeted is the Arctic Surfclam (Mactromeris polynyma).

There are currently licences for four offshore clam vessels, of which two are currently active. The offshore fishery is pursued by large freezer processors that fish on both Banquereau, Nova Scotia, and Grand Bank, Newfoundland. Effort has switched back and forth between these areas over time, with effort currently concentrated on Banquereau.

The management methods for the offshore clam fishery can be found in the Offshore Clams Integrated Fishery Management Plan, Maritimes and Newfoundland and Labrador regions (DFO 2011). The main management tools for the offshore clam fishery are limited entry licences, a TAC (total allowable catch) divided into EAs (enterprise allocations), 100% dockside monitoring, mandatory logbooks and VMS (vessel monitoring systems).

A survey of the Banquereau Arctic Surfclam stock (Figure 1) took place in 2010. This assessment provides a summary of the current status of the stock using the framework developed for the Banquereau Arctic Surfclam stock during Jan.- Apr. 2007.

This Science Advisory Report was developed during a Maritimes Region Science Advisory Process on 19-20 October 2011. Additional publications from this meeting will be made available on the Canadian Science Advisory Secretariat (CSAS) website at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Canada

SUMMARY

- Arctic Surfclams are long lived and slow growing. If the resource were to be depleted, it would take a long time for stock recovery.
- There is evidence of incoming recruitment, which is expected to enter the fishery in the near (over the next 5 years) and longer term (approximately 10 years). Overall, there is a broad range of ages present in the population, which indicates that the fishery is not dependent on incoming recruitment.
- Clam dredges have an immediate impact on the substrate and benthic organisms. There continue to be uncertainties about the long term impacts of dredges on overall benthic productivity. Hydraulic clam dredge fisheries occur on fairly mobile, well-sorted sand, which helps mitigate the overall impact on some elements of the benthic community.
- The proportion of clam species caught in the Arctic Surfclam fishery is spatially variable, and bycatch of non-clam species is low.
- The framework for Arctic Surfclam (2007) recommended a constant F approach, and the 2007 assessment recommended a target F of 0.33M.
- The current fishable biomass estimate (1,150,585 t) is highly uncertain due to the large confidence interval around the survey dredge efficiency (21-86%). This should be taken into consideration in the harvest strategy, including development of reference points and harvest control rules.

BACKGROUND

Species Biology

The **Arctic Surfclam** (*Mactromeris polynyma*) is a large, long lived species found mainly in coarse sand bottoms. It is a strong, active burrower, capable of burrowing several centimetres below the sediment surface (typically to the depth of the siphon). A distinguishing feature is that most specimens have a purple colour in the foot and mantle that turns red upon cooking, similar to lobster and shrimp.

In the western Atlantic, they occur from the Strait of Belle Isle to Rhode Island. In the Pacific they are found from the Juan de Fuca Strait to Point Barrow, Alaska, and also from Sakhalin Island, Russia. All Atlantic populations are sub tidal down to 110 m, but in Alaska there are intertidal populations as well.

Slow growing and long lived, significant numbers of surfclams appear to reach 40 years of age. On Banquereau, the oldest animal aged so far was 92 years old; the largest observed was 159 mm. On Grand Bank, the oldest clam aged so far was 73 years old, and the largest observed was 142 mm shell length.

The age and size at 50% maturity was determined to be 8.3 years and 45.2 mm shell length, respectively.

Based on life-history and selectivity parameter estimates, the age of maximum biomass per recruit occurs near the age of 50% selectivity of the commercial gear. Therefore, growth overfishing is unlikely to occur. The age of 50% maturity is also below the age of 50% selectivity (15.3 years), indicating that the average surfclam will be able to spawn over a period of 7 years before being recruited to the fishery. This should help ensure that recruitment overfishing does not occur, although there have been no studies of the relative fecundity of young versus older surfclams.

Fishery

Following a three month test fishery in 1986, an offshore Clam Enterprise Allocation Program was developed for **Arctic Surfclams** on Banquereau. The initial TAC of 30,000 t was reduced to 24,000 t following a survey in 1996-97. For most of the fishery, there have been three vessels active. This has dropped down to two for the past 5 years. The offshore fishery is pursued by large freezer processors that fish on both Banquereau, Nova Scotia, and Grand Bank, Newfoundland. Effort has switched back and forth between these areas over time, with effort currently concentrated on Banquereau (Figure 2).

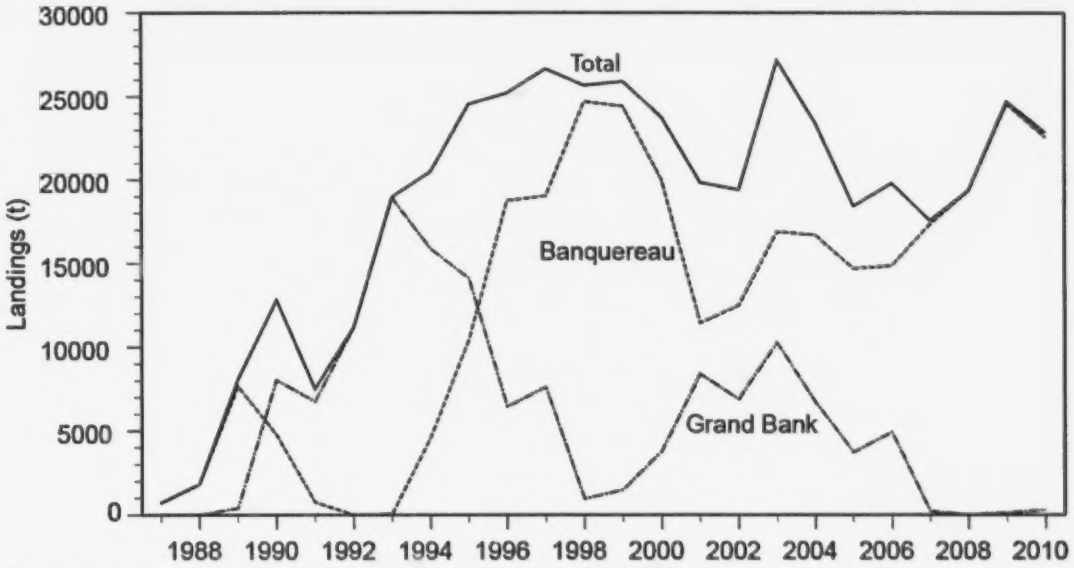


Figure 2. Arctic Surfclam landings(t) for Banquereau and Grand Bank.

ASSESSMENT

Stock Trends and Current Status

Fishing effort has declined, while catch and catch per unit effort (CPUE) have increased since 2005 (Figure 3). The increasing CPUE is thought to be related to a recruitment pulse currently entering the fishery and a variety of other fishery-related factors, such as changes in catching technology, mapping technology, and fishing experience. The spatial distribution of fishing effort within Banquereau has also changed through time (Figure 4). Due to these confounding factors, CPUE is not considered to be a good indication of abundance.

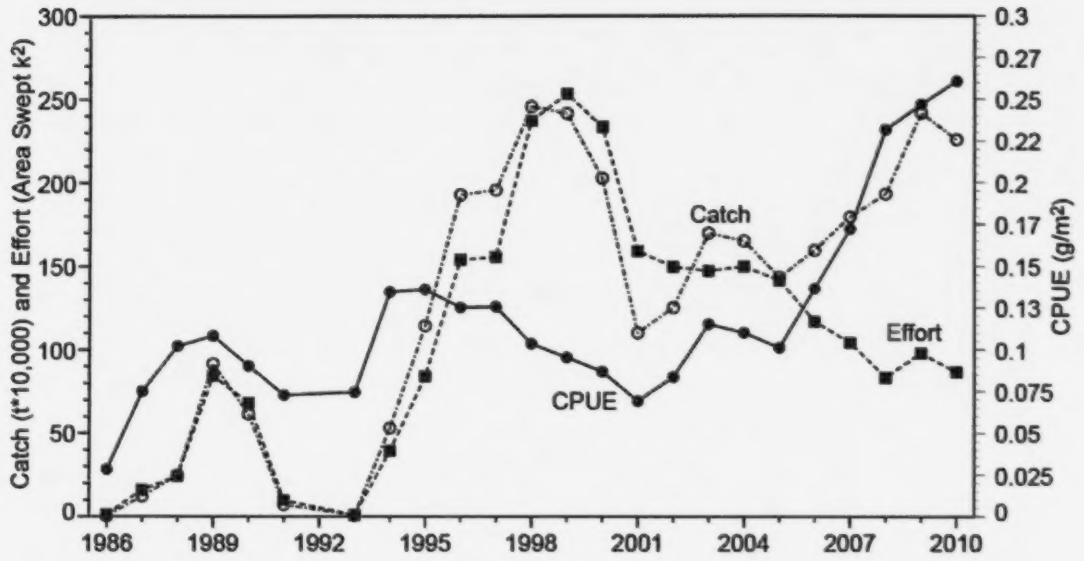


Figure 3. History of annual catch, effort and CPUE for the Arctic Surfclam fleet on Banquereau from Logbook data.

In addition to the survey in 1996-97, there were surveys of Banquereau in 2004 and 2010. Each survey used different vessels and gear.

The 2010 survey length frequencies show a pulse of clams that is in the process of entering the fishery (i.e., over the next 5 years), as well as a pulse between 5-10 years old that is expected to recruit to the fishery in approximately 10 years (Figure 5). Overall, there appears to be a broad range of ages present in the population, which indicates that the fishery is not dependent on incoming recruitment.

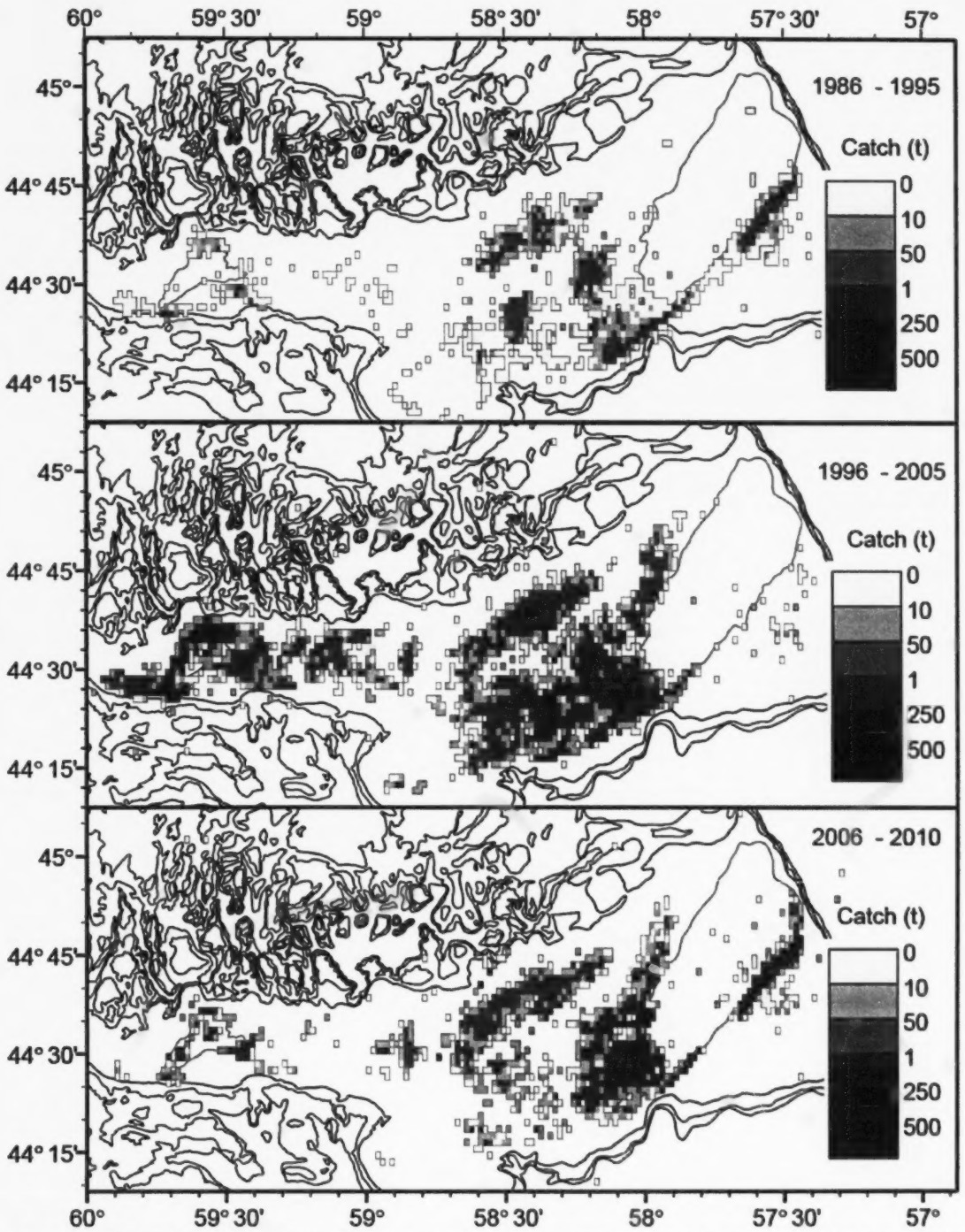


Figure 4. Distribution of the Arctic Surfclam catch on Banquereau. Catch is aggregated by one minute squares for the period listed.

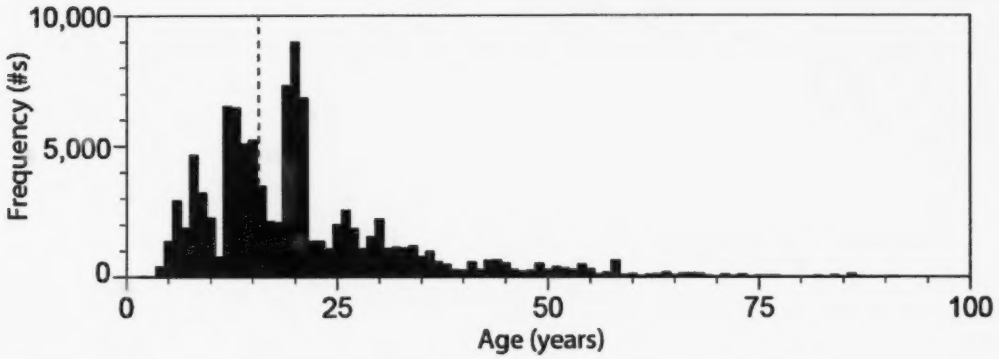


Figure 5. Estimated survey age frequency. Dashed line is age of 50% selectivity.

The Research Vessel Biomass Estimate (B_{RV}) from the 2010 Banquereau survey (798,085 t ± 17,891 t) was corrected to fishable biomass (518,223 t), as the survey dredge captures smaller clams than the commercial gear. It was then corrected for the survey dredge efficiency (1,150,585 t). The survey dredge efficiency was estimated with a depletion study that produced a best fit estimate of 45% efficiency with a 95% confidence interval of 21-86%. The confidence interval is large and skewed to higher values (Figure 6).

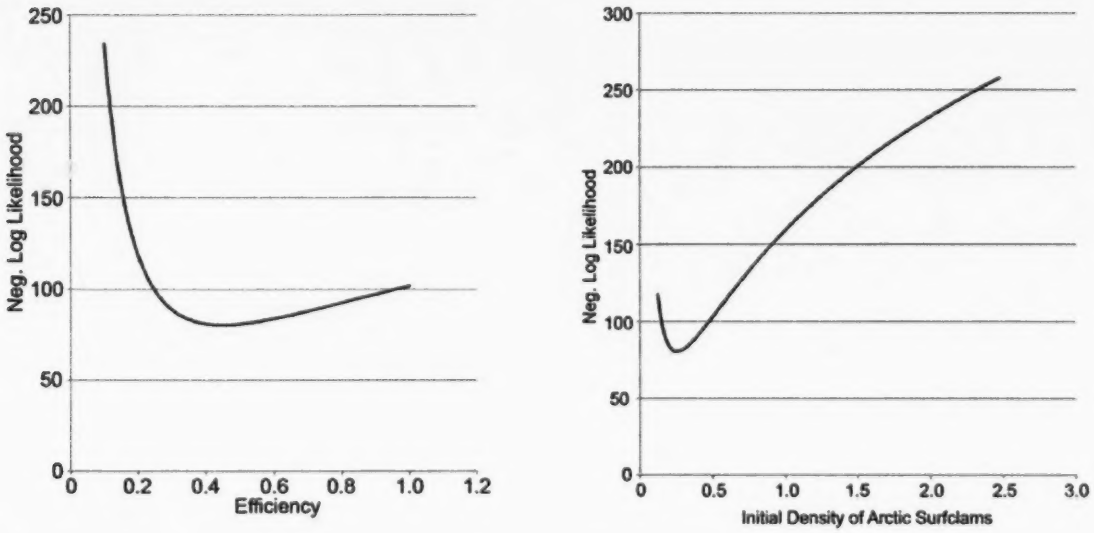


Figure 6. Likelihood profiles for the estimates of dredge efficiency and initial density of Arctic Surfclams from the depletion study on Banquereau during the 2010 Arctic Surfclam survey. The best estimate is the minimum negative log likelihood (i.e. lowest point on the graph).

Results from contouring the 2010 Banquereau Arctic Surfclam survey (Figure 7) indicate areas with a density of 75 g/m^2 or more contain 91% of the efficiency corrected fishable biomass (Table 1). This can be compared to the Grand Bank survey where 49% of the biomass was found at this density (Roddick et al. 2007).

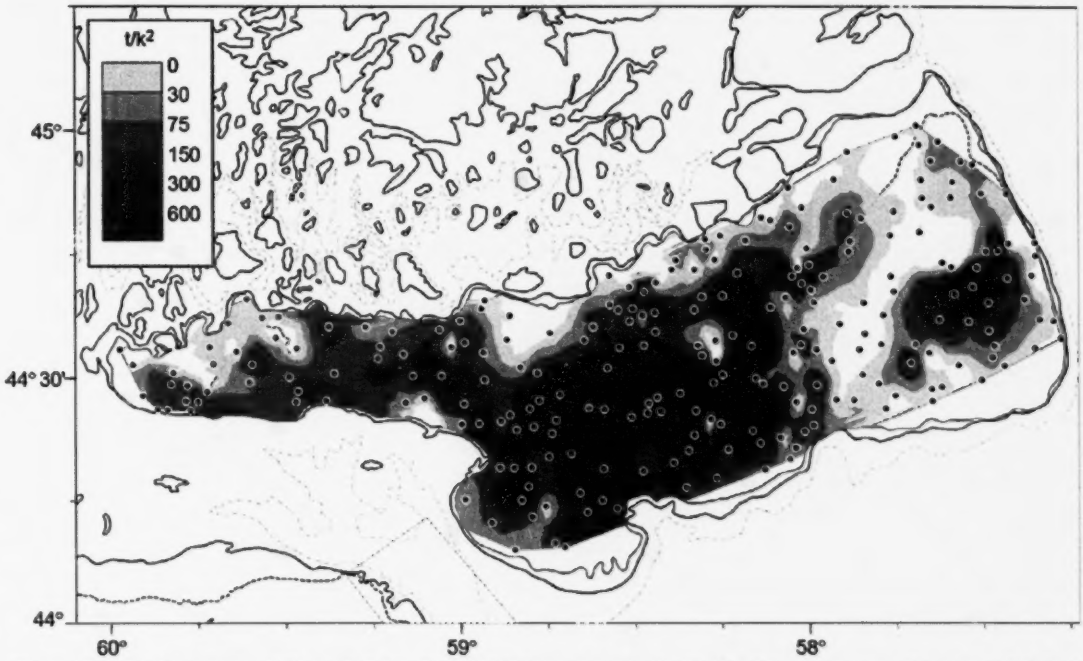


Figure 7. Contour map of the catch for the 2010 Banquereau Arctic Surfclam survey. Survey catch has been adjusted for dredge efficiency and commercial selectivity.

Table 1. Percent of total survey area and biomass within density contours for 2010 Banquereau Arctic Surfclam survey.

Density g/m²	% Area	% Biomass
>0	100	100
30+	80	98
75+	62	91
150+	38	71
300+	11	26
600+	0.5	2

Using three different methods, natural mortality (M) was estimated to be in the range of 0.076-0.082. An M of 0.08 was used in the past, and this assessment did not provide any evidence to suggest a change. Thus, for the purposes of this assessment, M for the Banquereau stock was assumed to be 0.08.

A calculation of the average landings in the last five years over the current estimated biomass gives a fishing mortality ($F_{2006-2010}$) of 0.017. In the past two years, F has increased to 0.02.

Ecosystem Considerations

Habitat

Clam dredges have an immediate impact on the substrate and benthic organisms because they liquefy the sediment down to at least 8 inches (20 cm), remove many large organisms and cause sedimentation adjacent to the track. On Banquereau, the impacts are being studied through an experiment at a site at 70 m depth. This is considered one of the most rigorous fishing gear impact studies done to date. The experiment demonstrated immediate impacts on

both habitat and non-target organisms. Within the first two years following dredging, there was considerable recovery of the composition of non-target benthic species, such as echinoderms, with a shift in relative abundance of the species present. Visual evidence of dredge tracks disappeared after one year (Gilkinson et al. 2005).

The experiment site was revisited 10 years later (in 2008) to investigate recovery of substrate and large clam species. Preliminary results indicate that sidescan sonar was still able to detect dredge tracks. In addition, there were few juvenile clams in the experimental grab samples (pers. comm. Kent Gilkinson, DFO Newfoundland). In comparison, 6 of 12 tracks at less than 40 m depth on Sable Bank were not detected one year later (pers. comm., Ned King, Atlantic Geoscience Centre).

There continue to be uncertainties about the long term impacts of dredges on overall benthic productivity.

With only two vessels currently active in the offshore clam fishery, the swept area estimated in km^2 (footprint) is relatively small compared to other mobile gear fisheries and the spatial extent of the target species. Since the Banquereau surfclam fishery began in 1986, annual swept area has averaged 104 km^2 or 1% of the available area of the bank (Figure 8). This area swept is not corrected for overlap of tows.

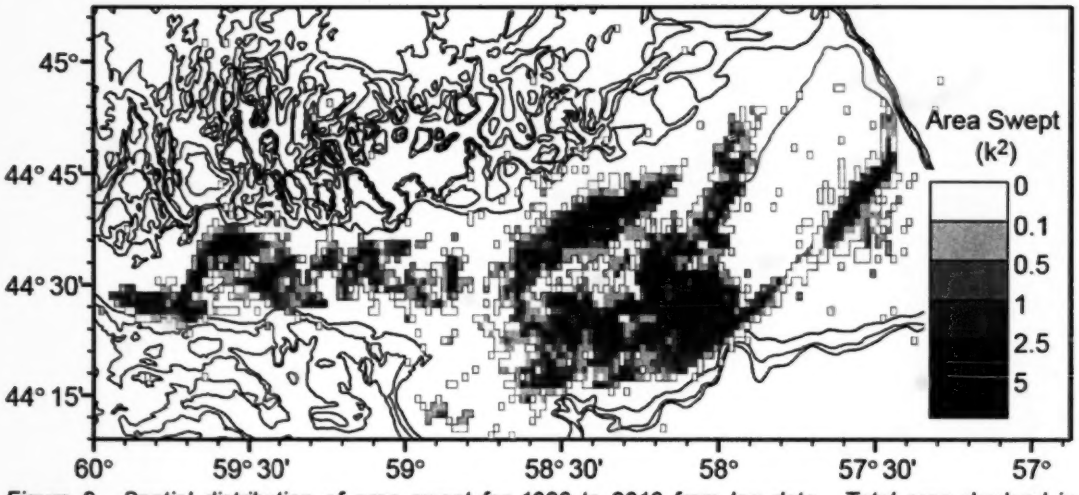


Figure 8. Spatial distribution of area swept for 1986 to 2010 from log data. Total area dredged is aggregated by one minute squares (not corrected for overlap of dredge tracks or logbook errors.

There is considerable spatial and temporal variation in area swept over the timeframe of the fishery, with areas of high clam biomass fished more frequently and intensely than other sections, and a period when the fishery concentrated on Grand Bank instead of Banquereau. The total area swept during the last 2 years of the fishery (2009-2010) is approximately 184 km^2 (Figure 9), representing the area undergoing recovery by the non-target species as indicated by the experimental results. This represents roughly 2% of the known surfclam habitat on Banquereau.

Hydraulic clam dredge fisheries occur on fairly mobile, well-sorted sand, which helps mitigate the overall impact on some elements of the benthic community (NMFS 2002).

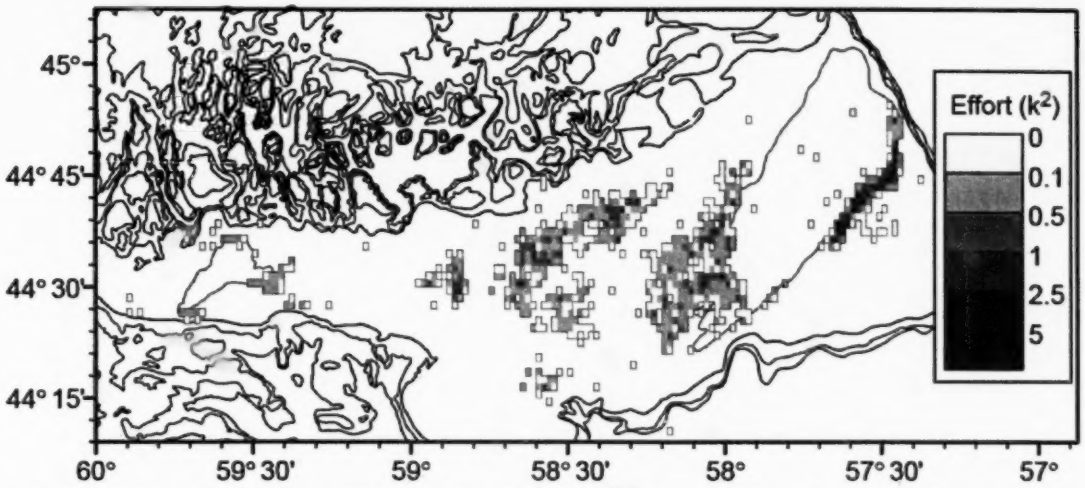


Figure 9. *Spatial distribution of area swept for 2009 and 2010 (approx. 184 km^2). Total km^2 dredged is aggregated by one minute squares (not corrected for overlap of dredge tracks)..*

Bycatch

The proportion of clam species caught in the Arctic Surfclam fishery is spatially variable, and bycatch of non-clam species is low (Table 2).

Bycatch results from three different sources (clam survey, commercial sampling, and the Observer Program) were reviewed. The three sources were generally consistent (i.e., overall proportion of surfclam and other main, mostly clam, species in the catch), but the catch composition from the commercial sampling is considered to be more representative of the fishery and is provided in Table 2. The bycatch in this fishery is almost entirely infauna and epifauna. The catch of finfish is negligible.

Table 2. Catch composition for the top 99% of the catch by weight from on-board sampling from commercial clam vessels from 1999 to 2009 on Banquereau.

Item	Weight (kg)	%	Cumm.%
Arctic Surfclams	3,722.33	49.69	49.69
Northern Propellerclams	1,180.99	15.76	65.45
Shell	988.16	13.19	78.64
Sand Dollars	899.85	12.01	90.65
Rocks	355.49	4.75	95.39
Greenland Cockles	111.00	1.48	96.88
Ocean Quahogs	73.42	0.98	97.86
Sea Mice	32.27	0.43	98.29
Blue Mussels	24.67	0.33	98.62
Whelks - *Buccinidae*	18.04	0.24	98.86
Waved Whelks	14.12	0.19	99.05

In 2010 survey tows with a catch of Arctic Surfclams of at least 100 g/m^2, representing areas likely to be fished commercially, Arctic Surfclams make up 42% of the catch (excluding shell and rock), followed by Sand Dollars (36%), Northern Propellerclams (9%), Sea Mice (*Aphrodita* sp.)(2%), Greenland Cockles(2%), Sea Cucumbers (*C. Frondosa*)(2%), Ocean Quahogs (1%), and Arctic Wedgeclams (1%). These eight are the only organisms that make up more than 1%

of the catch, and together account for 95% of the catch of living organisms from the areas likely to be fished.

Sources of Uncertainty

The surveys conducted to date produce abundance estimates that are different, and these differences appear to be related to changes in vessels and gear rather than an actual change in abundance. In addition, survey dredge efficiency was not available for any previous assessment. The approach has been to use the most recent data to produce the best estimate of the current abundance rather than a time series of comparable estimates.

Dredge efficiency in the 2010 survey was estimated to be 45% but is based on a single depletion experiment. The 95% confidence interval around the efficiency estimate is asymmetrical and ranges from 21 to 86%. Applying this efficiency estimate to the fishable biomass from the survey gives a total fishable biomass estimate of 1,150,585 t. Applying the 95% confidence interval for the efficiency estimate gives a biomass range from 602,585 to 2,457,729 t. This range uses only the confidence interval for the efficiency estimate. Variation around the survey fishable biomass estimate would increase this range.

The commercial dredge efficiency is expected to be higher than the survey dredge efficiency.

CONCLUSIONS AND ADVICE

The current fishable biomass estimate (1,150,585 t) is highly uncertain due to the large confidence interval around the survey dredge efficiency. This should be taken into consideration in the harvest strategy, including development of reference points and harvest control rules.

Arctic Surfclams are long lived and slow growing. If the resource were to be depleted, it would take a long time for stock recovery.

The framework for Arctic Surfclam recommended a constant F approach (DFO 2007a); a Science Response to clarify the advice stated that as F approaches 0.5 M, increased stock risk could be expected (DFO 2007b). As a result, the Banquereau assessment adopted $F_{0.33M}$ as an appropriate F (row 1, Table 3). This was considered a relatively risk-neutral point given the survey frequency and biological characteristics of the stock. The Grand Bank assessment showed that a large portion of the biomass was in low density areas, and the TAC was set by applying $F_{0.33M}$ to the biomass in areas with a density of at least 75 g/m^2. For comparison, a similar approach for Banquereau is shown in row 2, Table 3. Expected yield at the current TAC is also shown (row 3, Table 3).

Table 3. Example fishing mortality targets and yields for Banquereau.

Harvest Strategy	F	(t)	Comment
$F_{0.33M}$	0.026	30,375	$0.33MB_{RV}$
$F_{0.33M}$	0.026	27,592	$0.33MB_{>75}$
F_{TAC}	0.021	24,000	Equivalent to the current TAC of 24,000 t

There is evidence of incoming recruitment, which is expected to enter the fishery in the near (over the next 5 years) and longer term (approximately 10 years). Overall, there is a broad range of ages present in the population, which indicates that the fishery is not dependent on incoming recruitment.

Given the slow growth rate of Arctic Surfclam, a conservative approach to its management, and the cost of conducting offshore surveys, it is likely that assessment surveys for this stock will continue to occur infrequently. This increases the probability of vessel and gear changes between surveys. Reducing uncertainty of gear performance, such as dredge efficiency and selectivity, will be required to provide a more accurate estimate of abundance.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Advisory meeting of October 19-20, 2011, on the assessment of Arctic Surfclam on Banquereau. A meeting to develop the framework for this assessment was held February 1-3, 2011. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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